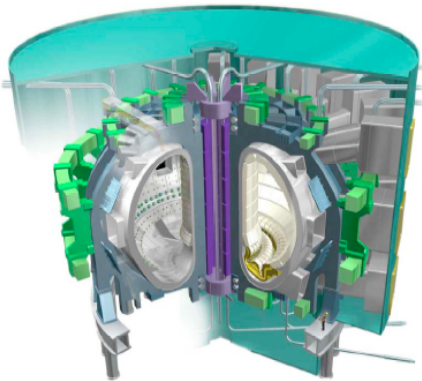


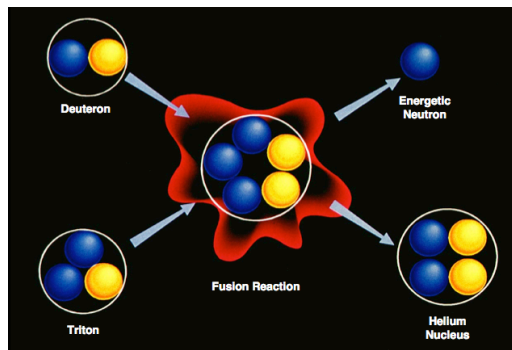
Activities of the U.S. Burning Plasma Organization



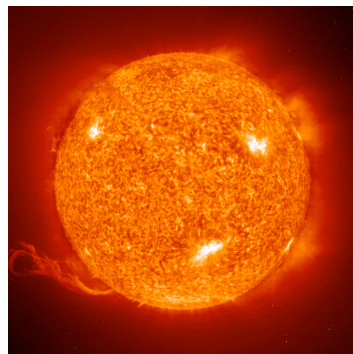
James W. Van Dam

Director, US Burning Plasma Organization

Chief Scientist, US ITER Project Office



USDOE/OFES Budget Planning Meeting
March 11, 2008



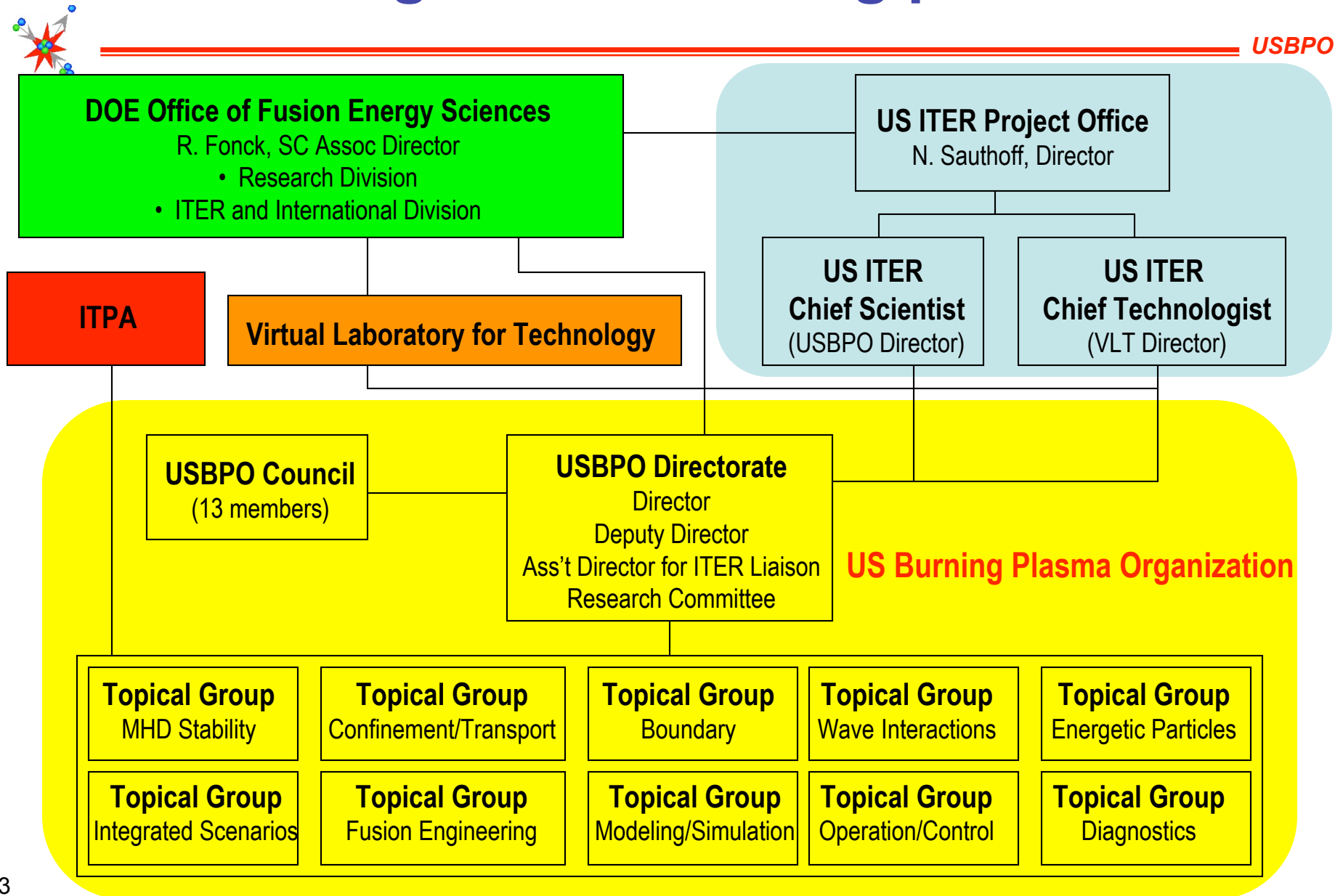
US fusion science community is actively preparing for a “burning plasma world”



USBPO

- **US Burning Plasma Organization created to organize community to prepare for, carry out, and benefit from burning plasma research**
 - Broad participation: 289 registered members from 49 institutions representing a cross-section of the community (magnetic confinement)
- **Strategic planning for burning plasma science:**
 - *EPAct Report* (2006): USBPO response to Energy Policy Act of 2005
 - Follow-on USBPO panel (led by E. Marmar): Long-term program plan for US burning plasma research and involvement in ITER
 - Other recent planning exercises
 - NRC Plasma 2010 Panel (led by S. Cowley and J. Peoples): *NAS Decadal Survey of Plasma Science and Engineering* (2007)
 - FESAC Panel (led by M. Greenwald): *Towards a Long-Range Strategic Plan for MFE* (2007)
- **US community is a major participant in the ITER design studies**
 - Design Review (21% of world-wide effort) + STAC Issues (22.5%)
 - Other U.S. research (not specific to the Design Review) continues to build the scientific basis needed for successful burning plasma experiment

Coordinating the US burning plasma effort



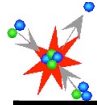
Diagnostics White Paper



USBPO

- **Emerged from USBPO Diagnostics Workshop (6-8 Feb 2007, San Diego)**
 - 50 onsite + 15 remote participants
- **Significant gap in US program:**
 - Need a funding mechanism in US program for development of innovative diagnostics for burning plasmas (ITER, companion experiments, DEMO)
 - USIPO supports in-kind procurement only for US-credited ITER diagnostics; some critical measurement needs are still unmet
 - 2007 OFES diagnostics solicitation supported diagnostics for existing experimental facilities (but excluded burning plasma diagnostics for upcoming facilities)
 - Led to the writing of *Diagnostics White Paper* (burningplasma.org/reference.html)
- **Proposed initiative (within existing OFES program):**
 - Expansion to support development of short/long-term new burning plasma diagnostics
 - Integration of capabilities of burning plasma diagnostics into analysis/simulation codes and control systems
 - Execution of specific short-term tasks (e.g., assess “thermonuclear” diagnostic issues, review ITER diagnostic systems of ITER Organization or other Parties, etc.)

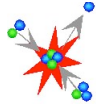
ITER un-credited diagnostic R&D needs



USBPO

Measurement	Required R&D	Priority
Confined alpha particles	New or very greatly evolved techniques	High
Lost alpha particles	New or very greatly evolved techniques	High
Magnetics	Radiation effects	High
Optical diagnostics	Erosion/redeposition, cleaning/restoring mirrors	High
Dust	New techniques	High
Tritium inventory and retention	New techniques	High
Optical diagnostics	New self-calibration techniques	Intermediate
Instability features (core & edge plasma regions)	Soft X-ray	Intermediate
Fuel composition	Fast wave reflectometry	Intermediate
Tile erosion	New techniques	Intermediate
Impurities	New techniques	Intermediate
Core fluctuations	New techniques	Longer term

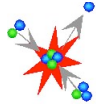
Other Topical Group activities



USBPO

- **Waves TG organized a workshop on plasma-wave interactions (May 2007)**
 - Following the 17th Topical Conference on RF Power in Plasmas (Clearwater, FL)
- **Modeling & Simulation TG members participated in Fusion Simulation Project meeting (May 2007, Wash DC) and wrote white paper about FSP integrated simulations for ITER**
- **Transport TG organized a Verification & Validation Task Group**
 - Reported initial findings reported at 2007 Transport Task Force annual meeting
 - Drafted a manuscript that is almost ready to be submitted for publication
- **Biweekly video-conference meetings of Research Committee & Executive Committee**

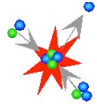
ITER Design Review



USBPO

- **Working with US ITER Project Office on ITER Design Review activities has been primary focus for USBPO during 2007 and into 2008**
- **Design Review Coordinator: G. Janeschitz (EU)**
 - Issue Cards (~400) assigned to 8 Design Review Working Groups
 - USBPO worked primarily with WG-1 (Design Requirements and Physics Objectives), which had 12 tasks
- **USBPO coordination (2007):**
 - **March:** List of US experts, effort estimates, and priorities for WG 1 tasks; discussed with US program leaders; sent by USIPO to Design Review WGs and ITER IO
 - **March:** ITER IO guidance about PT resource allocations for design review
 - **May:** WG1 subtask leaders contact US and international experts for work
 - **June:** OFES Guidance Letter in response to OMB decision
 - **July:** Revised list of US experts/effort/tasks provided to USIPO, which initiated paperwork with US institutions for work packages

Important design issues for ITER



USBPO

- **Some key issues:**
 - Heat loads:
 - Control coils and/or pellet pacing for ELM suppression
 - Control coils for Resistive Wall Modes (RWMs)
 - Disruption mitigation (also involves halo currents, forces on structures, etc.)
 - Heating systems mix
 - Ripple and Test Blanket Modules (TBMs)
 - Choice of plasma-facing components (PFCs); tritium retention
 - Plasma start-up; vertical stability
 - Definition of “First Plasma”
- **Recent studies to be discussed in following talk by R. Hawryluk**

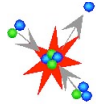
Broad spectrum of US community has been involved in ITER Design Review Activities



USBPO

- Involvement has occurred through USIPO, USBPO, ITPA, and VLT
- Work of technical experts performed through Design Review USIPO contracts and/or base program support
- **WG 1:** ~100 (\pm) technical experts, from >10 institutions (US and CA)
- **Additionally, ~24 official US participants on the 8 Working Groups**
- **Enormous effort, on an urgent time scale**
 - Made possible by the willingness of US program leaders to make qualified technical experts available for Design Review work
- **Also, significant amount of ITER-relevant research by fusion energy science community (experiments, theory, simulation)**

Addressing the STAC Issues



USBPO

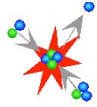
- **Time table:**

- **Sept 2007:** ITER Design Review officially “concluded”
- **Nov 2007:** STAC-2 reviewed Design Review findings, identified several key issues, and recommended further analysis of these key issues
- **Nov 2007–Jan 2008:** ITER Org and Domestic Agencies formed 13 topical working groups and developed work plan to address STAC issues

- **Effort:**

- Total = 217.5 professional person-months (PPM)
- Distribution among ITER partners:
 - US = 49.1 PPM (22.5%)

STAC Issues Working Groups



USBPO

Topic	Title	IO, US, & other DA leaders
T01	T01.a. Vertical stability T01.b. Shape control / poloidal field coils T01.c. Flux swing in OH operations and CS	D. Campbell, D. Humphreys (1.a), C. Kessel (1.b-c), G. Saibene (EU)
T04	ELM control	G. Johnson, R. Hawryluk, G. Janeschitz
T05	Remote handling	A. Tesini, B. Nelson, C. Damiani (EU)
T06	Blanket manifold remote handling	G. Johnson, M. Hechler, G. Federici (EU)
T07	First wall strategy (divertor armor)	M. Merola, M. Hechler, G. Federici (EU)
T08	Capacity of 17 MA discharge	D. Campbell, J. Wesley
T09	Cold coil test	P. Weng, J. Miller, M. Huguet (EU)
T10	Vacuum vessel / blanket loading condition	G. Sannazzaro, B. Nelson, G. Federici (EU)
T11	Test blanket modules strategy	V. Chuyanov, B. Nelson, L. Giancarli (EU)
T12	Hot cell design	M. Benchikhoun, B. Nelson, E. Di Pietro (EU)
T13	Heating current drive strategy, diagnostics, & research plan	D. Bora, E. Synakowski, J. Jacquinet (EU)

STAC activities

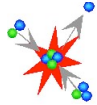


USBPO

- **STAC = Science & Technology Advisory Committee**
 - Reports to ITER Council
 - STAC chair is P. Kaw (IN)
 - US members: R. Goldston, T. Taylor, S. Milora, J. Van Dam, E. Oktay
- **STAC meetings:**
 - STAC-1 (Sept 5-6, 2007)
 - STAC-2 (Nov 5-7, 2007)
 - STAC-3 (Apr 7-9, 2008)
 - STAC-4 (May 19-21, 2008)
 - STAC-5 (Oct 20-22, 2008)
- **STAC briefings:**
 - USBPO helped organize several video-conference briefings prior to STAC meetings and Integrated Design Review meetings



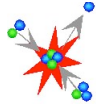
Coordination among major facilities



USBPO

- **U.S. National Tokamak Workshop (Sept 17-19, 2007, MIT)**
 - Significant consideration of ITER-specific research needs at this workshop
 - Many of the discussion facilitators were USBPO Topical Group leaders
 - ITER research needs have been incorporated into integrated 5-year research plans for C-Mod, DIII-D, and NSTX
- **6th IEA Large Tokamak Workshop on ITPA Coordinated Research Recommendations (Nov 29-30, 2007, Abingdon, UK)**
 - ITER-relevant joint experiments (~90) among international facilities
- **Annual Meeting of U.S. Fusion Facilities Coordinating Committee**
 - Sponsored by DOE/OFES; held the day before the Budget Planning Meeting; currently chaired by R. Hawryluk
 - Program leaders and PAC chairs of 3 major facilities + OFES managers

ITPA Developments



USBPO

- **Integration with USBPO**

- ITPA (international) \longleftrightarrow USBPO (national)

- **Structure**

- 7 Topical Groups at present: Diagnostics, Pedestal/Edge, Divertor/SOL, MHD, Confinement Database & Modeling, Transport, Steady State
- Coordinating Committee (chaired by R. Stambaugh)
 - Participated in ITPA CC meeting (June 18-20, 2007)

- **Activities:**

- ITPA workshops: twice/year for each topical group
- Published *Progress in ITER Physics Basis* (Nucl Fusion, June 2007)
- Nov 2007: 6th IEA Large Tokamak Workshop on ITPA Coordinated Research Recommendations (~90 joint experiments)

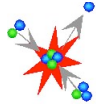
- **Invited to operate under the auspices of ITER Org**

- Charter adapted (Feb 28); Topical Groups may change

ITPA



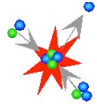
NRC Panel for review of EPAct Report



USBPO

- **Plasma Standing Committee of the National Research Council**
 - Sept 28. 2007: USBPO presentation to PSC/NRC (C. Greenfield)
 - Set up “Committee to Review US ITER Science Participation Planning Process” (CRISPPP)
- **CRISPPP meeting (Dec 14-15, 2007)**
 - Presentations from OFES (E. Oktay), USIPO (N. Sauthoff), VLT (S. Milora), and USBPO (J. Van Dam and E. Marmar)
 - International presentations: J. Pamela (EFDA), S. Matsuda (JAEA), D. Campbell (IO)
 - All presentations posted on USBPO web site
- **Metrics information provided to CRISPPP (Mar 2008): examples**
 - US authorship for “Progress in the ITER Physics Basis” (27%)
 - ITER-related experiments at major US facilities ($\geq 50\%$)
 - US lead/co-authorship of ITER session papers at 2006 IAEA Fusion Energy Conference (lead on 3 out of 12 orals, lead on 6 posters and co-authors on 6 others out of 44 total posters)
 - Participation in Design Review (21%) and STAC Issue WGs (23%)
- 15 • **CRISPPP report expected to be completed by ~ end of March**

Other USBPO activities



USBPO

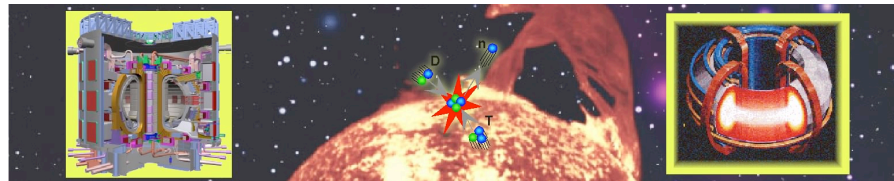
- **APS Division of Plasma Physics Meeting (Nov 2007)**
 - Town Meeting on ITER Design Review (Tuesday evening) with invited speakers G. Janeschitz, R. Hawryluk, R. Stambaugh
 - <http://burningplasma.org/reference.html>
 - First Microns of the First Wall mini-conference (organized by U.S. Edge Coordinating Committee with USBPO support)
 - Prepared list of burning plasma-related contributions at the meeting: 1 (tutorial); 1 (review); 8 (invited); 10 (oral); 58 (poster); 22 (mini-conf); 3 talks (town meeting)
 - USBPO tutorial talk: “The Scientific Challenges of Burning Plasmas”
- **Winter School (Jan 2008, UCLA)**
 - Joined forces with week-long CMPD/CMSO Winter School for one day of lectures on Alfvén instabilities in burning plasmas (~100 students)

Communication and outreach

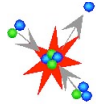


USBPO

- **eNews monthly newsletter**
 - “Director’s Corner” column, feature articles, announcements, reports, calendar of fusion events
 - Posted on USBPO web site and circulated electronically
 - Editor: R. Nazikian
- **USBPO web site (www.burningplasma.org)**
 - All USBPO presentations are publicly available
 - Limited-access pages for Council subcommittees, STAC materials, ...
- **Outreach**
 - Played support role in helping USIPO prepare ITER exhibition booth for AAAS Annual Meeting (Feb 2008)
 - Technical input (especially D. Batchelor; also PPPL and GA)



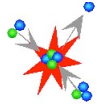
Other USBPO presentations



USBPO

- **Special session at APS April Meeting (Jacksonville, FL)**
 - USBPO invited talk: *How to Make a Big International Science Project Happen: Lessons from ITER*
- **Symposium on Simulation Science (NIFS, Toki, Japan, Sept 2007)**
 - Invited talk: *Simulation Science for Burning Plasmas*
 - Panel discussion presentation: *Comments on US Simulation Programs: SciDAC, FSP, USBPO, and ASC*
- **FESAC meetings**
 - USBPO presentations at March 2007 and July 2007 meetings
- **Fusion Power Associates Annual Meeting and Symposium (Dec 2007, Oak Ridge)**
 - Invited talk: *The US Burning Plasma Organization Activities* (N. Uckan)

Thinking ahead...



USBPO

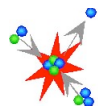
- **Return to broader research scope**
 - Further work on ITER issues of interest to US that arose from the Design Review
 - Re-assess other important burning plasma tasks identified prior to Design Review (Task Group model: e.g., PFCs/materials, pedestal dynamics, ...)
- **Further enhance USBPO coordination with ITPA and VLT**
 - Disseminate information via trip reports, meeting summaries, internet seminars, ...
- **A second Burning Plasma Workshop?**
 - Possible subject: development of ITER operating scenarios (Task Group)
 - Perhaps after the ITER integrated research plan is presented
- **Specific funding for “burning plasma science” in OFES budget?**
 - Examples: innovative BP diagnostics, ITER scenario development, pre-DEMO studies, BP integrated modeling, BP engineering science,



Preparing for burning plasma research

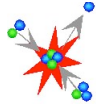
USBPO

- **Much effort has gone into supporting the ITER Design Review and the STAC Issues activities**
 - Broad participation across the U.S. community, organized by USIPO, USBPO, VLT, and ITPA
 - U.S. contributions (21%–23%) have exceeded U.S. share of ITER (9%)
 - We want to build an ITER that can successfully achieve its mission
- **In parallel with the ITER design review, USBPO continues to work on broader burning plasma issues that will lead toward a predictive understanding of plasma behavior**



SUPPLEMENTAL SLIDES

USBPO leadership team



USBPO

Directorate:

- *Director*: James Van Dam
- *Deputy Director*: Chuck Greenfield
- *Asst Director for ITER Liaison*: Nermin Uckan

• Topical Groups (10)

- 289 regular members
- 5 associate members (non-US-based): **NEW**

• Research Committee

- Consists of TG leaders and deputy leaders

Council:

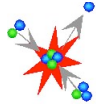
- *Chair*: Amanda Hubbard
- *Vice-Chair*: Mike Zarnstorff #
- 12 other members

Administrator: Emily Hooks

Communications Coordinator: Jim DeKock

On leave of absence (NRC Panel)

Council Members



USBPO

Amanda Hubbard (MIT) — *Chair*

Michael Zarnstorff (PPPL) — *Vice Chair* [1]

Steven Allen (LLNL)

Steven Cowley (UCLA) [2]

Richard Hawryluk (PPPL)

Earl Marmor (MIT)

Gerald Navratil (Columbia)

William Nevins (LLNL)

Martin Peng (ORNL)

David Petti (INL)

Craig Petty (GA)

John Sarff (Wisconsin)

Tony Taylor (GA) [1]

George Tynan (UCSD)

Ex-officio participants:

James Van Dam (Texas)

USIPO Chief Scientist

Stanley Milora (ORNL)

USIPO Chief Technologist

DOE/OFES:

Erol Oktay

ITER & International Division

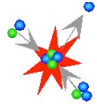
Gene Nardella

ITER Technology Officer

[1] ***On leave of absence (NRC Panel)***

[2] ***Moving to UKAEA Culham***

Topical Groups



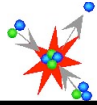
USBPO

Topical Group	Leader	Deputy Leader
MHD, Macroscopic Plasma Physics	Jon Menard (PPPL)	Chris Hegna (UW)
Confinement and Transport	Paul Terry (UW)	Ed Doyle (UCLA)
Boundary	Dennis Whyte (MIT)	Tom Rognlien (LLNL)
Plasma-Wave Interactions	Cynthia Phillips (PPPL)	Steve Wukitch (MIT)
Energetic Particles	Raffi Nazikian (PPPL)	Joe Snipes (MIT) [1]
Integrated Scenarios	Chuck Kessel (PPPL)	Tim Luce (GA)
Fusion Engineering Science	Nermin Uckan (ORNL)	Richard Nygren (SNL)
Modeling and Simulation	Don Batchelor (ORNL)	Jon Kinsey (Lehigh)
Operations and Control	Dave Humphreys (GA)	Dave Gates (PPPL)
Diagnostics	[2]	Jim Terry (MIT) Steve Allen (LLNL)

[1] Formerly: Bill Heidbrink (UCI)

[2] Formerly: Rejean Boivin (GA)

ITPA meetings during 2007



USBPO

TOPICAL GROUP	LOCATION	DATE	COMMENT
Diagnostics	Princeton, USA	26-30 Mar	
Transport Physics	Lausanne, Switzerland	7-10 May	
Confinement Database & Modeling			
Pedestal and Edge	Garching, Germany	7-10 May	
SOL & Divertor Physics			
Steady State Operation	Daejeon, Korea	9-11 May	Before IAEA TCM on Steady State Operation
MHD	San Diego, USA	21-24 May	
Coordinating Committee	Cadarache, France	18-20 June	
Transport Physics	Naka, Japan	1-3 Oct	After H-Mode Workshop (26-28 Sept, Tsukuba)
Confinement Database & Modeling			
Pedestal and Edge			
MHD	Garching, Germany	11-12 Oct	After IAEA TCM on Energetic Particles (8-10 Oct)
Steady State Operation	Garching, Germany	15-17 Oct	
Diagnostics	Chengdu, China	29 Oct–2 Nov	
SOL & Divertor Physics	Toledo, Spain	7-10 Jan 2008	In conjunction with PSI paper selection meeting
IEA/ITPA Joint Expt Planning	Abingdon, UK	29-30 Nov	